CHM

APR 4 1966

X4A9.1/80
9 March 1966

APPROACH TO A KEYBOARD STANDARD FOR ASCII

1. The charter of X4A9.1 is to develop a "standard" keyboard to implement the ASCII. There seems to exist considerable vagueness as to what such a standard might be except for a lacy picture of the office electric typewriter keyboard. Yet, a casual study of the draft proposed standard should reveal that this is not proving a very firm guide. Most office typewriters add extra graphics on keys 36 and 56 which the proposed standard reserves for "function" keys. On the opposite hand, the assignment of graphics to keys 3, 4, 17 and 18 invades areas where most office typewriters employ "function" keys. By the count on the fingers, the keys reserved for unidentified "functions" are inadequate in number to operate an office correspondence typewriter much less any modern device for the manipulation of information in some undefinitized manner. Also, it should be found that 11 of 16 symbol combinations and 6 of 6 special graphic combinations generally are not found in the electric typewriter.

2. At this point it is appropriate to reconsider the qualities of a keyboard arrangement that would make it useable in a broad variety of applications:

a. The arrangement should draw from the past and present everything that is advantageously useful to the current and forseeable future situations.

b. The arrangement should be influenced by current physical structures but this influence should not be carried to the level at which it becomes dictation.

c. The arrangement should permit the logic implementation to be as simple as possible.

d. The arrangement should provide grouping, to the maximum extent possible, of characters leaving a logical inter-relationship.

e. The arrangement should provide for shifting some characters, or groups of characters, within the arrangement without necessitating the moving of prime control keys and prime graphic keys.

f. The arrangement should retain as a basic graphic core the QWERTYUIOP, or Scholes, arrangement of alpha characters.

g. The arrangement should provide a cluster, or clusters, of prime control keys in such manner that other control keys which become prime to a particular environment may be conveniently added to the cluster, or clusters.

h. The arrangement should provide the minimum number of keys which represent a reasonable compromise between logic implementation and manipulation by the operator.

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i. The arrangement should avoid using shift keys in combinations.

j. The arrangement should require a minimum of retraining of operators whose basic training is with the office typewriter or the 5-bit teletypewriter.

3. Before any further discussion, some terminology must be defined so that clear understanding may be achieved:

a. Graphic key - a key in the arrangement whose first order assignment is for the initiation of logic operations to produce the ASCII bit representation assigned to the graphic character or characters with which it is labelled.

b. Control key - a key in the arrangement whose first order assignment is for the initiation of logic operations to produce the ASCII bit representation assigned to the control character with which it is labelled. A second order assignment is usually considered unpractical for such keys.

c. Shift key - a key which does not produce a discrete code (bit representation) but which is used to direct which code of a multiple coded key will be produced. In present practice this is usually understood to mean a choice between two graphic characters and is labelled SHIFT.

d. Control shift key - a key which does not produce a discrete code but which is used to permit graphic keys to assume a second order assignment of a control character (in accompanying arrangements it is labelled CTL).

e. Graphic - one of the 96-character subset of the ASCII appearing in columns 2 through 7 of the code table.

f. Control - one of the 32-character control subset of the ASCII appearing in columns 0 and 1 of the code table.

4. Character pairing. In developing a keyboard arrangement having less keys than the number of codes or characters to be produced, some form of pairing (two or more characters sharing the same key) must be adopted. In the general case, the logic implementation (whether it be mechanical, electrical, or a combination of the two is most simply done if one bit is the common difference between the characters sharing the key. This is not to say that other pairings are not possible (even, perhaps, most economical under certain conditions) because, for example, the Royal McBee Corp. proposal maintains the electric typewriter pairings.

To return to one-bit-difference pairs, the ASCII dictates upper case and lower case alpha pairs based on bit 6. The twelve other characters in this area of the code are not related as are the letters of the alphabet but an arbitrary up-lo carry through for these characters is probably justified frst by economics and second by admitting to the good possibility that many applications will make graphic

character substitutions in this area.

With the remaining 32 graphics there are interesting combinations available as canbe seen from the tables of pairs appended. The meat of interest in planning a minimal sized arrangement can be charted if based on some reasonable premises. For example; if Space must have a discrete key in all arrangements, and two numerics cannot be paired on one key in any arrangement, then the key requirements are:

shifting bit	b1	b2	b3	b4	b5
maximum pairing	22	22	21	19	17
max. pairing except commas and period	24	22	23	21	19
shift-free numerics	22	24	24	25	27*
shift-free numerics, comma and period	24	24	26	27	29*

*Provides 2 sets of numerics in one arrangement

b5, as a shifting bit, offers the minimum number of keys without shift-free numerics and for the case of both a row and a cluster of numerics; requires the maximum number of keys for shift-free numerics and provides the maximum match with the pairing of the electric typewriter.

The other bits offer minimum key requirements in connection with shift-free numerics. b1 and b2 tie for low key honors and therefore a choice between them would have to be made on the basis of the resulting character pairs---and that could be controversial.

5. Assembly. Well planned components are essential to any successful assembly. For a number of high population devices there will be desired an arrangement of the minimum practical number of keys of which certain control keys are a prime requirement. These may be named as HT(or TAB), LF, CR, BS which have discrete codes assigned in the ASCII and shift controls which do not have a discrete code assignment. These shift controls may be: CTL (control shift) whose purpose is to permit graphic keys to perform in a secondary role of producing control codes of relatively low frequency usage; SHFT (Shift) whose purpose is to choose between two graphic characters on a graphic key; and UP-CASE (upper case) whose purpose is to set the letter keys so that only the codes for the upper case, or capital, letters are produced.

According to the human factors experts these prime keys are best located when clustered in such manner that they remain in be same location while other variations are made

within the arrangement and that they do not serve as separators for groups of graphic keys.

Let the arrangement begin by placing some controls on keys 4, 44, 64, and 65 and some on keys 18, 58, 78 or 79 and 75 or 76. This forms two control clusters with keys 24 and 38 potentially available for expansion. If to this the QWERTYUIOP alpha block is added with Q on key 25 a skeleton arrangement is achieved which has variation possibilities which are practically independent of the selection of shift bits.

These possibilities are more readily appreciated when placed in context with a complete arrangement. Therefore, a number of arrangements are presented for the purpose of demonstrating that a hard core of alpha graphics and prime controls can lend itself to many variations and in turn show the way to one, two or three "standard arrangements" suitable for a great many applications. The complete set of controls is not shown on all arrangements but would be the same graphic-control pairing as shown in documents 83 and 90.

6. In summary: the arrangements of documents 71 and 81 through 94 illustrate the approach set forth in sections 4 and 5 satisfies the criteria set forth in section 2;

the arrangements indicate the approach of sections 4 and 5 equally feasible for row numerics, clustered numerics, and shift-free or shift-sensitive numerics;

the character of the numeric cluster may be that of the IBM keypunch, the Bell System touch tone dial and the ten-key adding machine with equal ease and some variations of each;

the information separators may be effectively clustered in any of the arrangements;

the five possible combinations of shifting bits are useable but that the combinations b6b5 and b6b1 are probably the most practical;

the periphery of all arrangements is available for adding special keys to adapt the arrangement to particular applications.

7. Proposal:

Arrangements 81 through 85 be studied to develop a shift-free numeric cluster "standard";

Arrangements 90 through 93 be studied to develop a shift-sensitive numeric row and/or cluster "standard."

The concept of "prime control keys" presented in section 5 be studied and, if found acceptable, discretely defined.

Henry C. Umstead

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TABLE OF PAIRS FOR ARRANGEMENTS

b1 pairs

```
SP  " $ & (  * , .   0 2 4 6 8 : < >
    ! # % ' ) + - /  1 3 5 7 9 ; = ?
```

b2 pairs

```
SP  ! $ % ( ) , -    0 1 4 5 8 9  < =
    " # & ' * + ./     2 3 6 7  : ; > ?
```

b3 pairs

```
SP  ! " # ( ) * +  0 1 2 3 8 9 : ;
    $ % & ' , - ./   4 5 6 7 < = > ?
```

b4 pairs

```
SP  ! " # $ % & '  0 1 2 3 4 5 6 7
    ( ) * + , - ./   8 9       : ; < = > ?
```

b5 pairs

```
SP  ! " # $ % & ' ( )   0 1 2 3 4 5 6 7 8 9 * + , - . /
    0 1 2 3 4 5 6 7 8 9                     : ; < = > ?
```

b6 pairs

```
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z  [ \ ] ^ _
a b c d e f g h i j k l m n o p q r s t u v w x y z  { | } ~ DEL
```

b7 pairs

```
NUL SOH STX ETX EOT ENQ ACK BEL BS  HT LF VT  FF CR SO SI
 @   A   B   C   D   E   F   G   H   I  J  K   L  M  N  O

DLE DC1 DC2 DC3 DC4 NAK SYN ETB CAN EM SS ESC FS GS RS US
 P   Q   R   S   T   U   V   W   X  Y  Z  [  \  ]  ^  _
```

TABLE OF PAIRS FROM THE CODE TABLE

b5 pairs

```
SP ! " # $ % & ' ( ) * + , - . /
0 1 2 3 4 5 6 7 8 9 : ; < = > ?
```

b4 pairs

```
SP ! " # $ % & ' 0 1 2 3 4 5 6 7
( ) * + , - . / 8 9 : ; < = > ?
```

b3 pairs

```
SP ! " # ( ) * + 0 1 2 3 8 9 : ;
$ % & ' , - . / 4 5 6 7 < = > ?
```

b2 pairs

```
SP ! $ % ( ) , - 0 1 4 5 8 9 < =
"  # & ' * + . / 2 3 6 7 : ; > ?
```

b1 pairs

```
SP " $ & ( * , . 0 2 4 6 8 : < >
!  # % ' ) + - / 1 3 5 7 9 ; = ?
```


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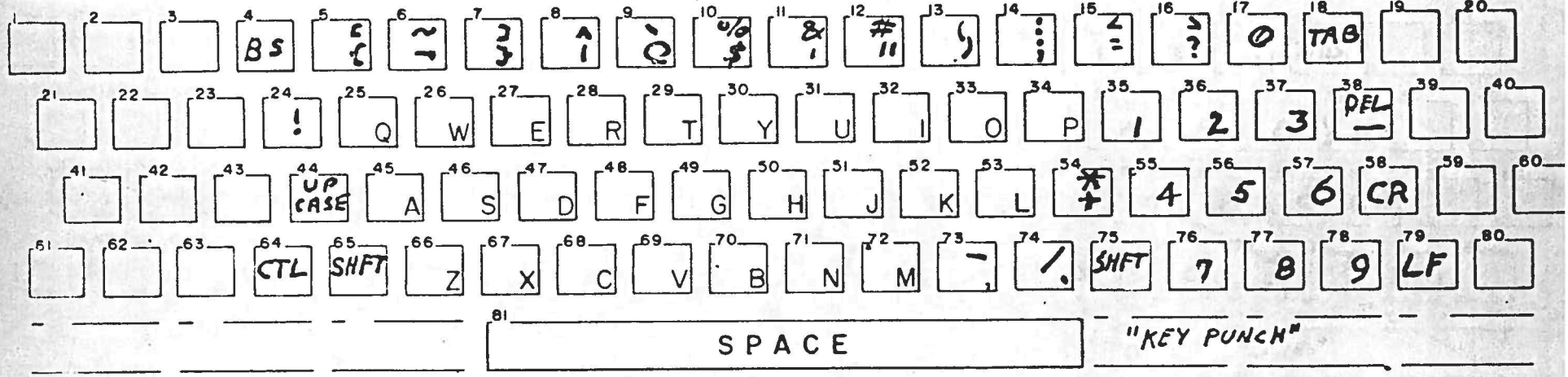
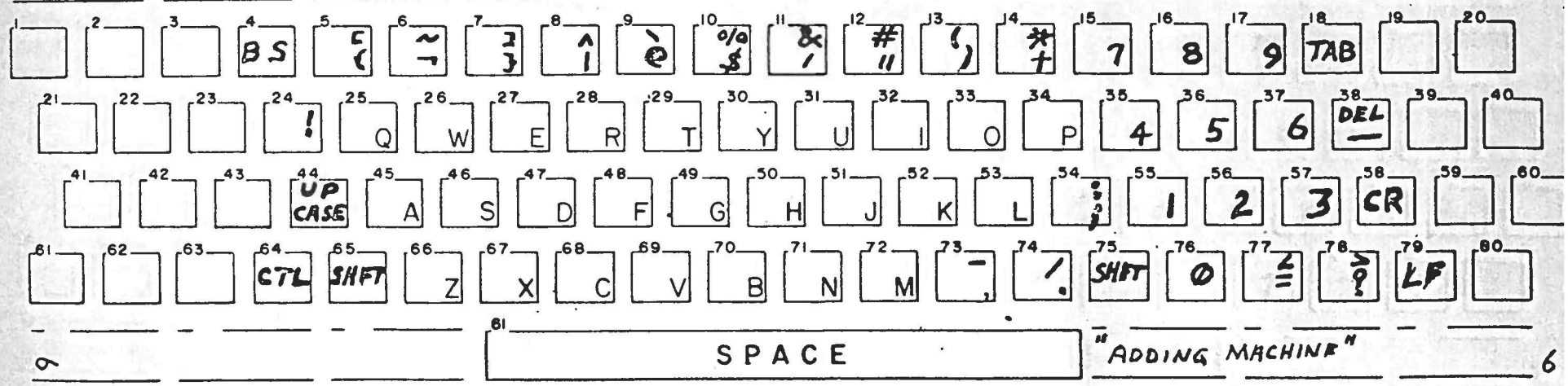
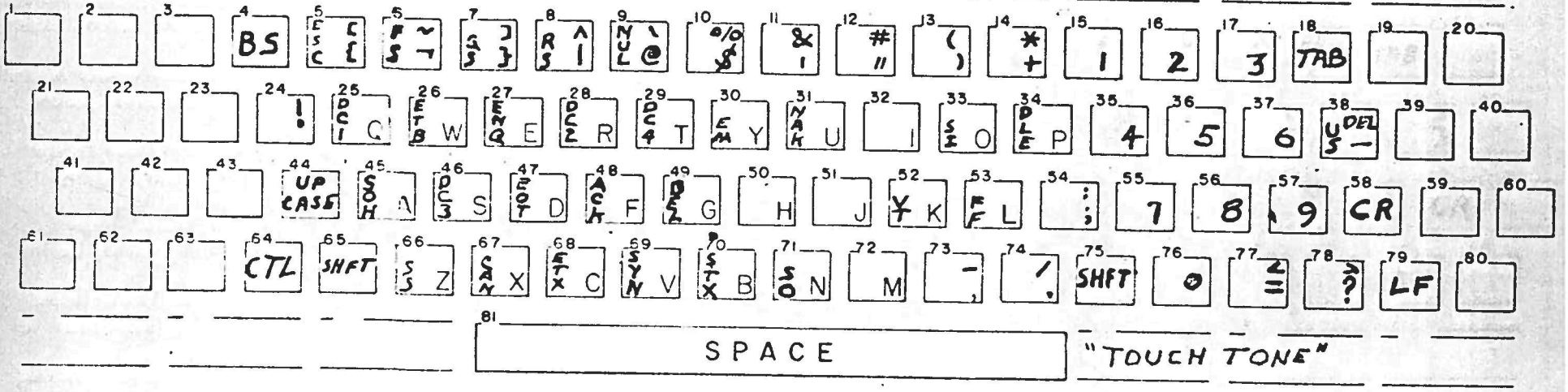
54 & 8 KEY: B61 ASCII KEYBOARD ARRANGEMENT X4A9-1/81



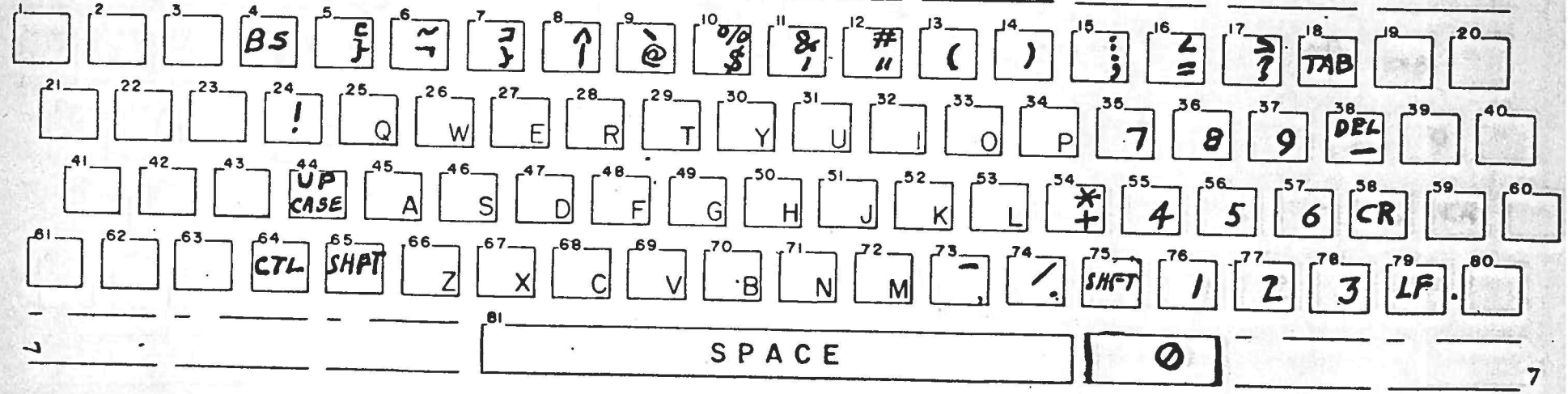
54 & 8 KEY: B61 ASCII KEYBOARD ARRANGEMENT X4A9-1/82



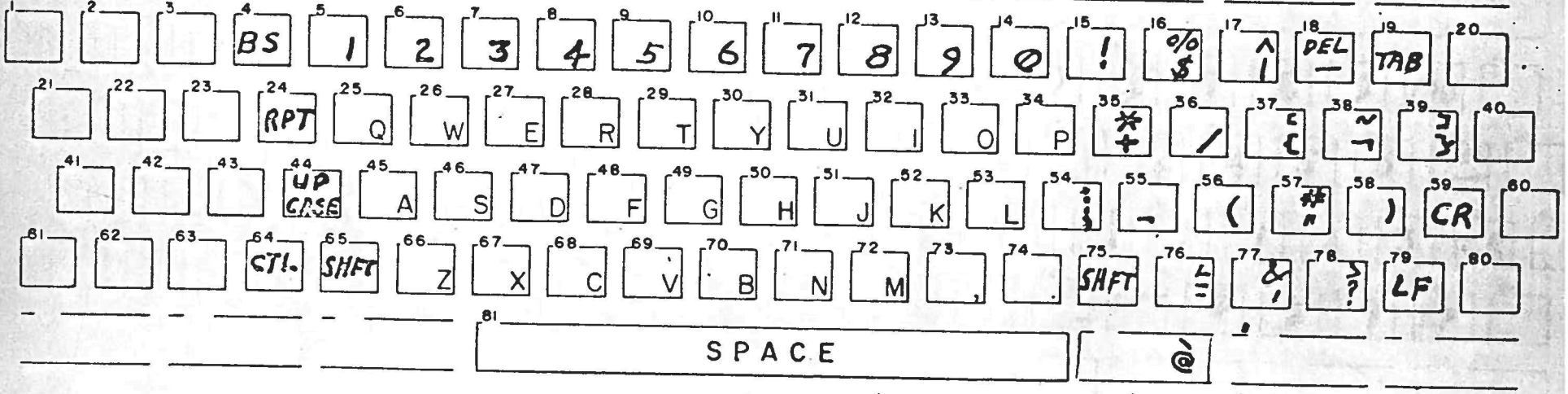
54 & 8 KEY: B61 ASCII KEYBOARD ARRANGEMENT X4A9-1/83



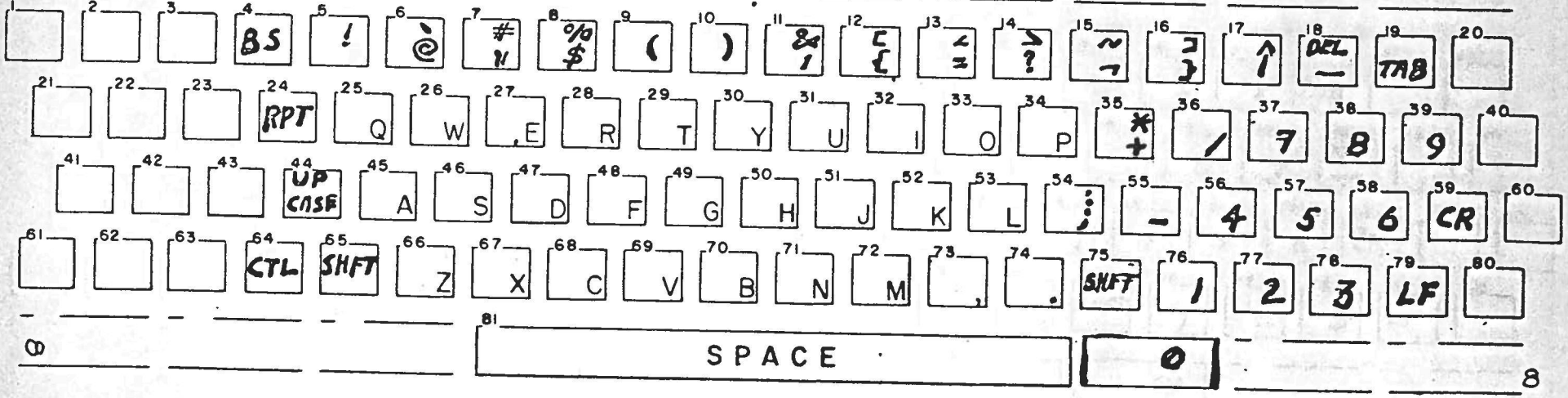
55 & 8 KEY: B61 ASCII KEYBOARD ARRANGEMENT X4A9-1/84



57 & 9 KEY: B61 ASCII KEYBOARD ARRANGEMENT X4A9-1/85

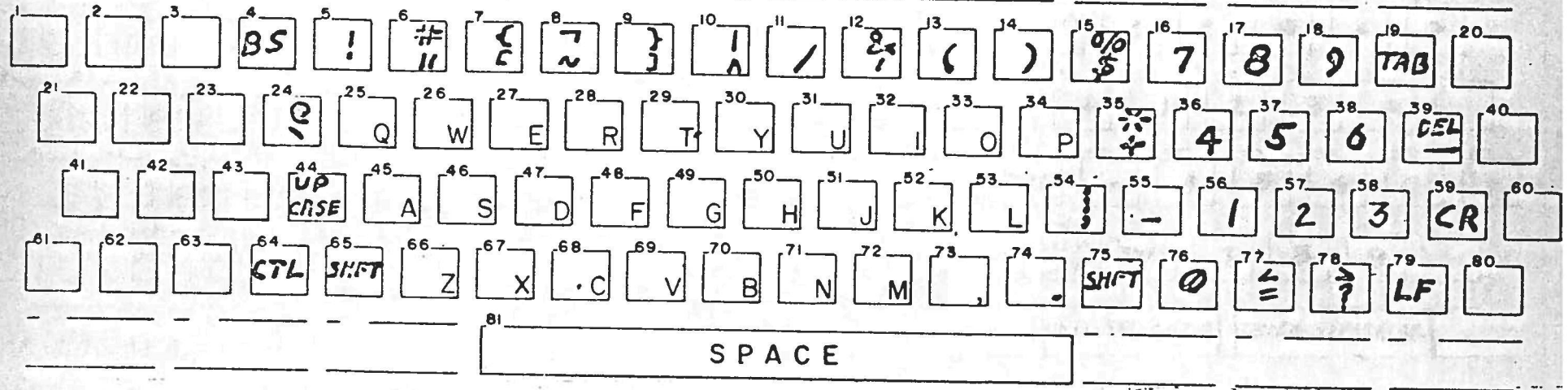


57 & 9 KEY: B61 ASCII KEYBOARD ARRANGEMENT X4A9-1/86



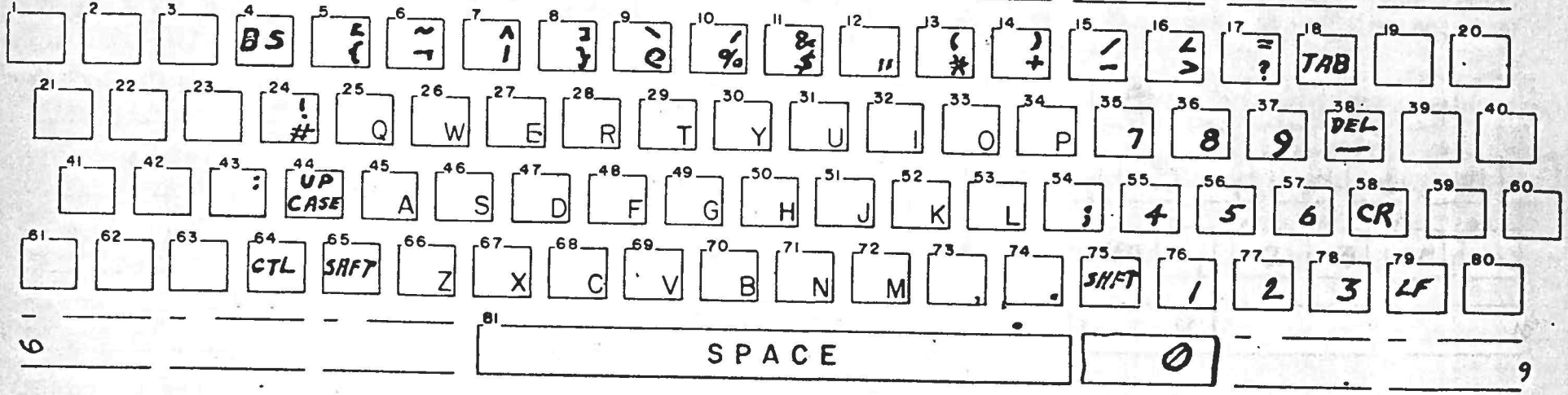
57 & 8 KEY:

B61 ASCII KEYBOARD ARRANGEMENT X4A9-1/87



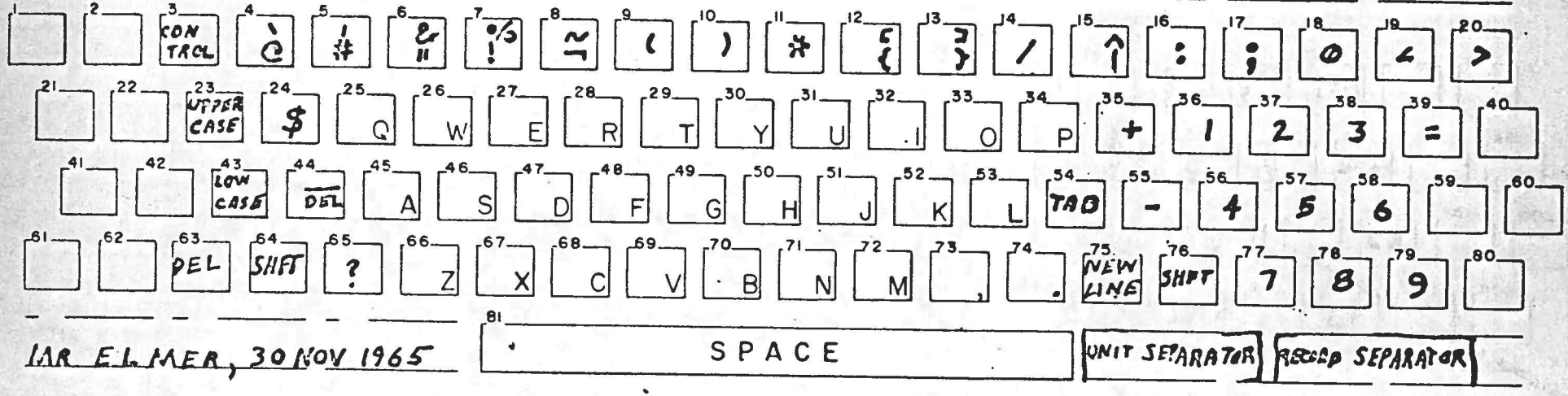
56 & 8 KEY:

B62 ASCII KEYBOARD ARRANGEMENT X4A9-1/88



61 & 9 KEY: B63

ECMA/TC1/55/83 SUGGESTED DATA PREPARATION KEYBOARD ARRANGEMENT X4A9-1/71



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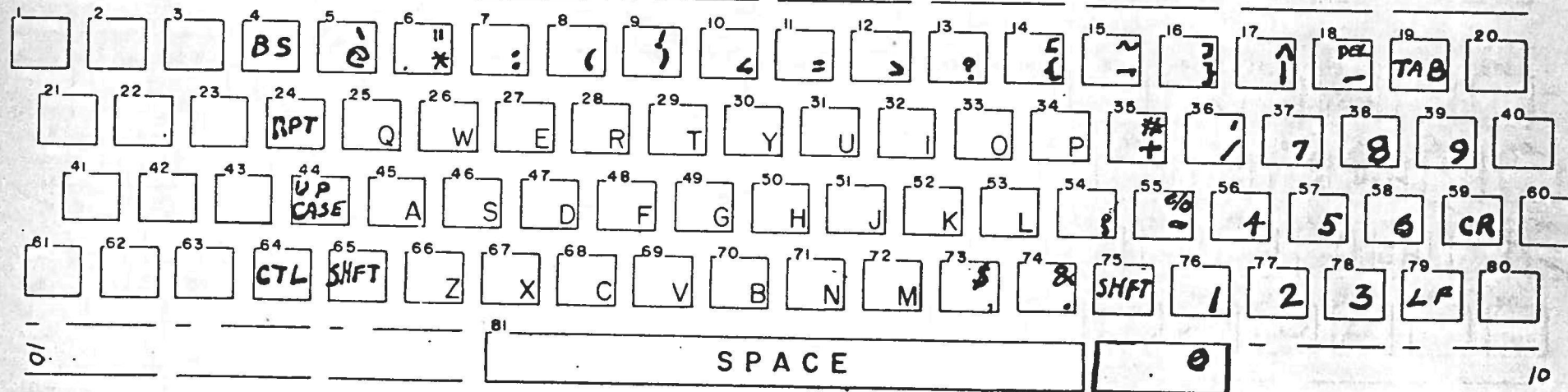
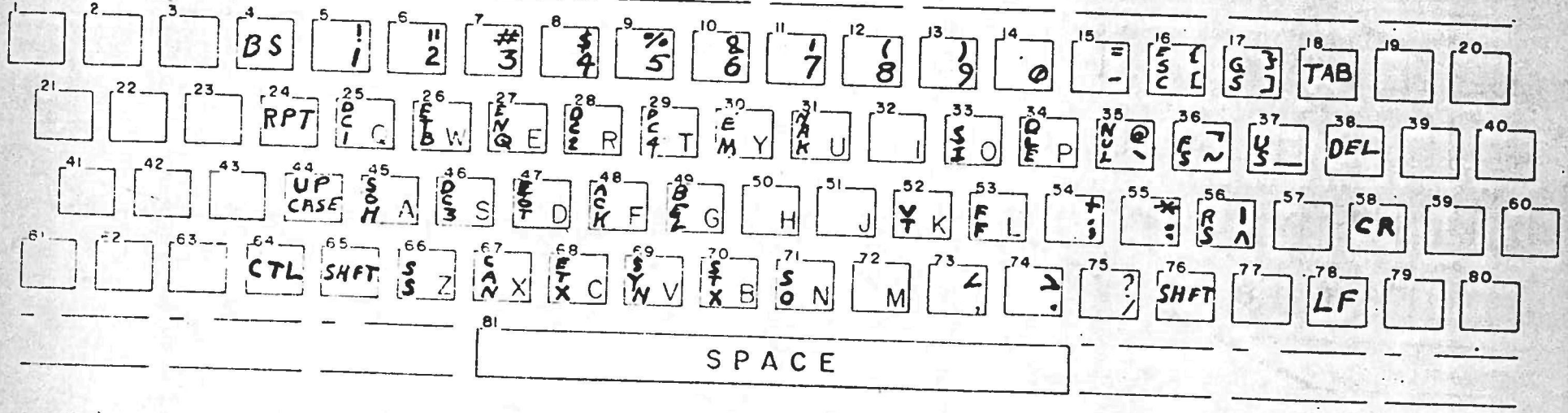
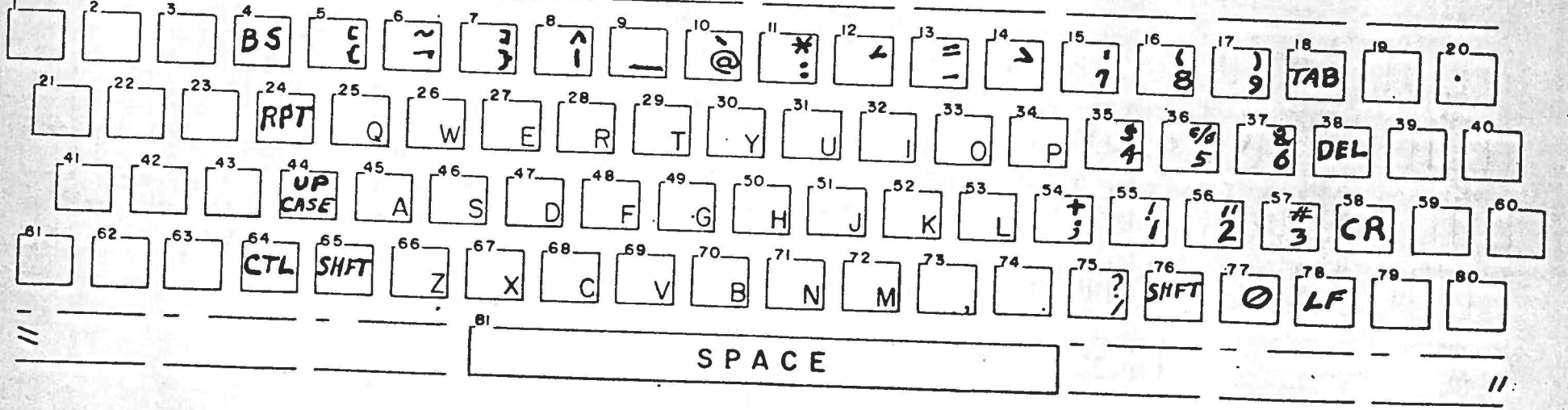
57 & 9 KEY: B64 ASCII KEYBOARD ARRANGEMENT X4A9-1/89



50 & 10 KEY: B65 ASCII TTY KEYBOARD ARRANGEMENT X4A9-1/90

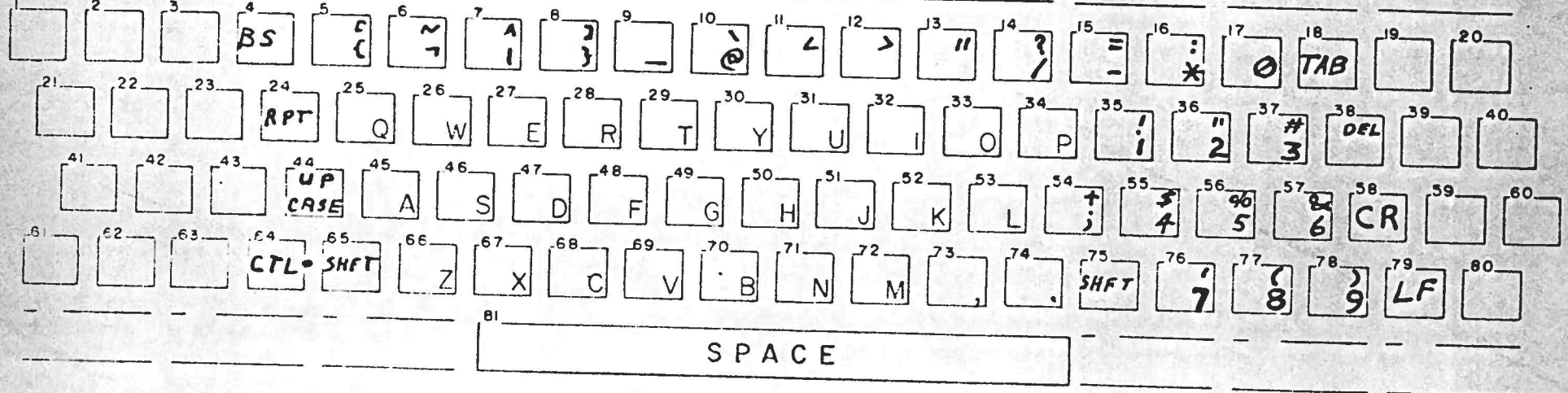


52 & 9 KEY: B65 ASCII KEYBOARD ARRANGEMENT X4A9-1/91



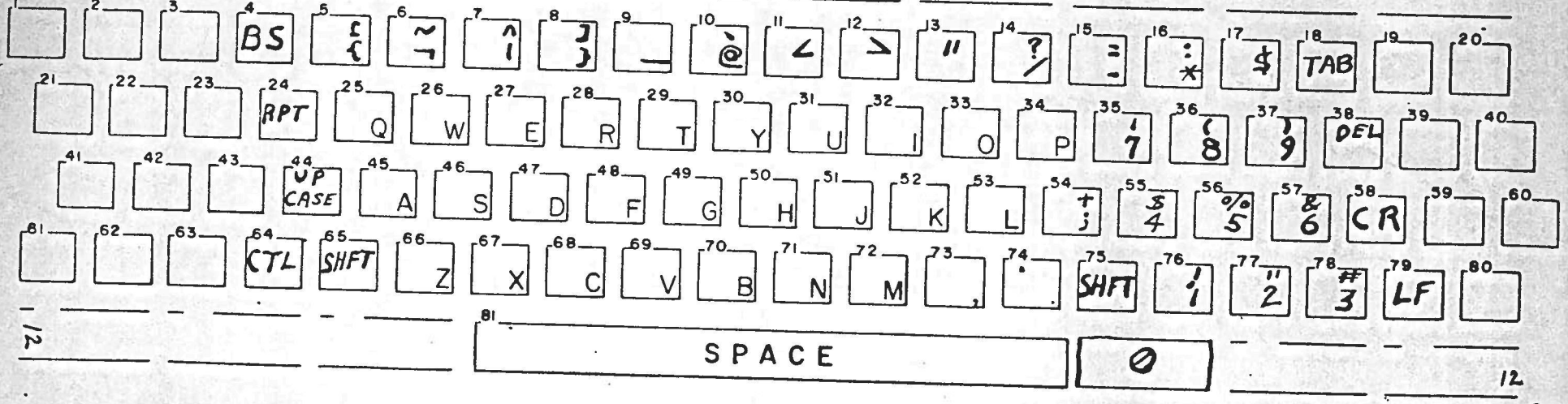
53 & 9 KEY:

B65 ASCII KEYBOARD ARRANGEMENT X4A9-1/92



54 & 9 KEY:

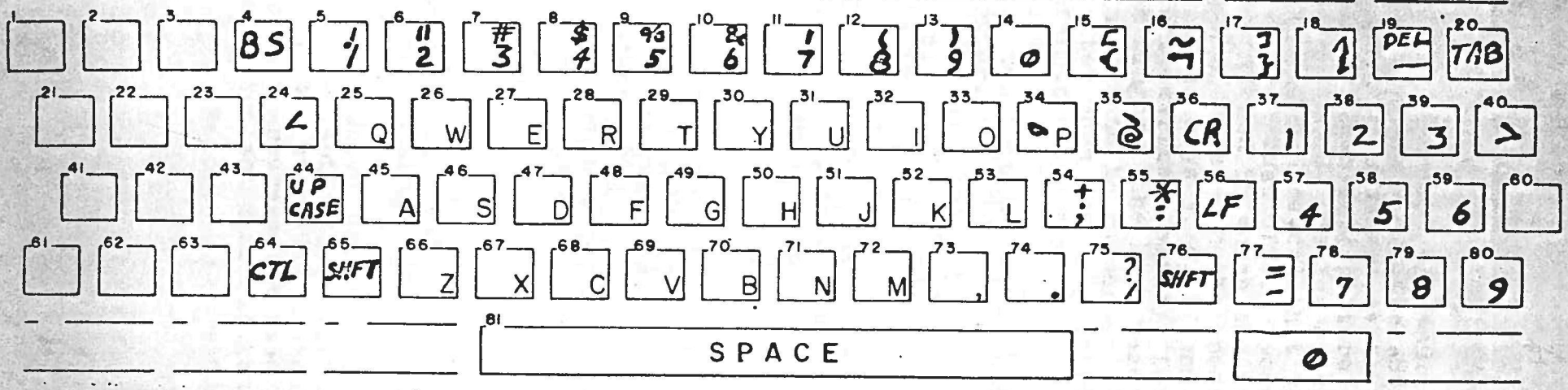
B65 ASCII KEYBOARD ARRANGEMENT X4A9-1/93



12

12

61 & 8 KEY: B65 ASCII KEYBOARD ARRANGEMENT X4A9-1/94



47 # KEY: ELECTRIC TYPEWRITER PREFERRED KEYBOARD ARRANGEMENT X4A9-1/